Land Use Planning for Integrated Water Management

December 12, 2012

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Preliminary Findings

- There are few user-friendly tools which test and compare Low Impact Development scenarios

- Data is inconsistently available
  - Maintenance
  - Green infrastructure

- Less infrastructure is cheaper
  - Most cost effective residential development has least impervious surfaces

Project Objectives

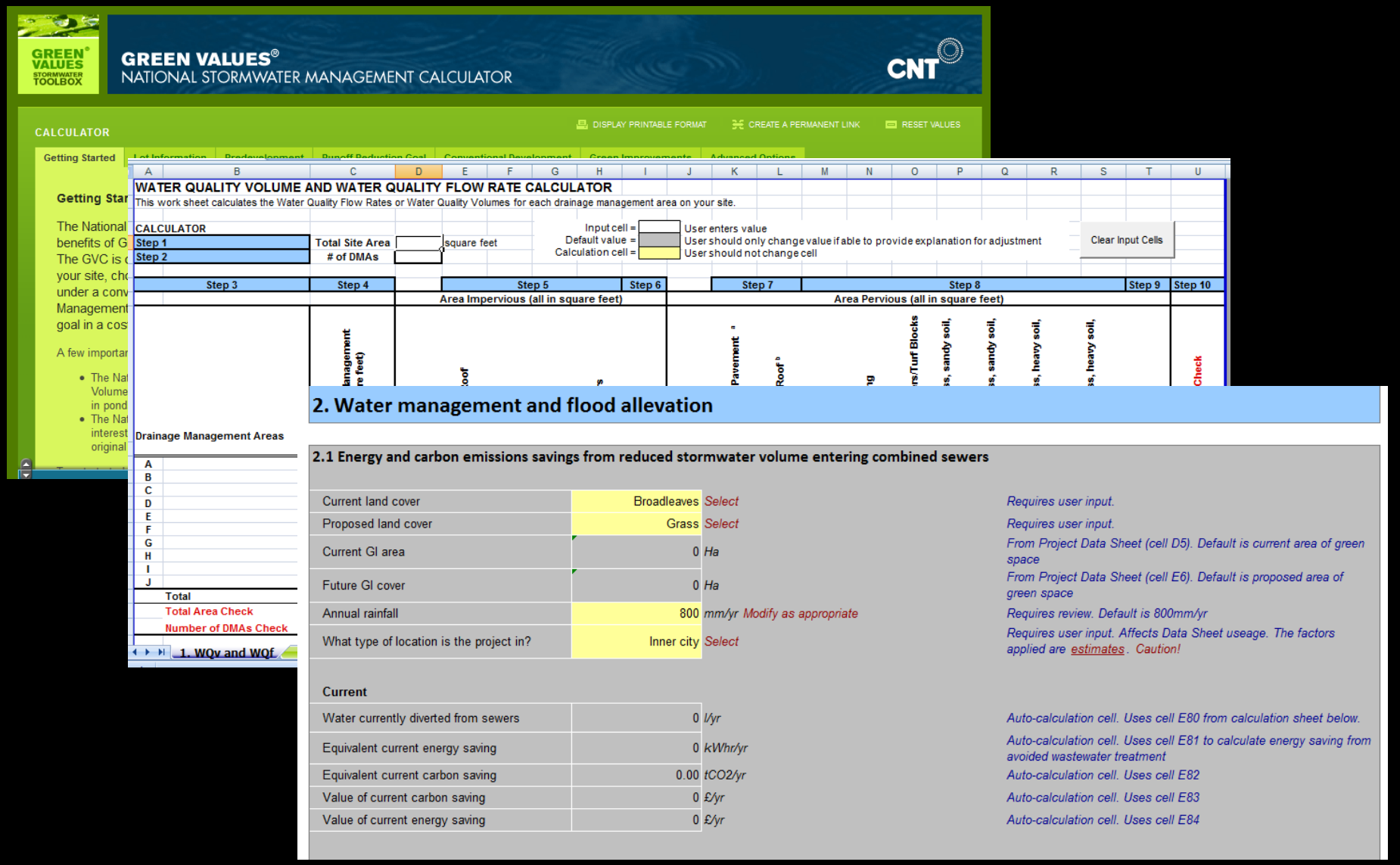
1. Quantify relationship between land use and water supply benefits:
   - Water supply reliability
   - Flood management
   - Water quality
   - Habitat value
   - Climate Action Mitigation

2. Create an accessible tool which can be used to help guide land use decision making

Approach

- Review existing tools
- Develop new tool
- Apply to case studies
- Quantify differences in case studies
- Identify lessons learned

Tool Review


GREEN VALUES®
NATIONAL STORMWATER MANAGEMENT CALCULATOR
CNT
CALCULATOR
DISPLAY PRINTABLE FORMAT
CREATE A PERMANENT LINK
RESET VALUES
Getting Started
WATER QUALITY VOLUME AND WATER QUALITY FLOW RATE CALCULATOR
This work sheet calculates the Water Quality Flow Rates or Water Quality Volumes for each drainage management area on your site.
CALCULATOR
Step 1
Step 2
Total Site Area
# of DMAs
square feet
Input cell =
Default value =
Calculation cell =
User enters value
User should only change value if able to provide explanation for adjustment
User should not change cell
Clear Input Cells
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8
Step 9
Step 10
Area Impervious (all in square feet)
Area Pervious (all in square feet)
Check
Drainage Management Areas
Total
Total Area Check
Number of DMAs Check
1. WQv and WQf
2. Water management and flood allevation
2.1 Energy and carbon emissions savings from reduced stormwater volume entering combined sewers
Current land cover
Broadleaves
Select
Requires user input.
Proposed land cover
Grass
Select
Requires user input.
Current GI area
0
Ha
From Project Data Sheet (cell D5). Default is current area of green space
Future GI cover
0
Ha
From Project Data Sheet (cell E6). Default is proposed area of green space
Annual rainfall
800
mm/yr
Modify as appropriate
Requires review. Default is 800mm/yr
What type of location is the project in?
Inner city
Select
Requires user input. Affects Data Sheet useage. The factors applied are estimates. Caution!
Current
Water currently diverted from sewers
0
l/yr
Auto-calculation cell. Uses cell E80 from calculation sheet below.
Equivalent current energy saving
0
kWhr/yr
Auto-calculation cell. Uses cell E81 to calculate energy saving from avoided wastewater treatment
Equivalent current carbon saving
0.00
tCO2/yr
Auto-calculation cell. Uses cell E82
Value of current carbon saving
0
£/yr
Auto-calculation cell. Uses cell E83
Value of current energy saving
0
£/yr
Auto-calculation cell. Uses cell E84

Lessons from Existing Tools

- Comprehensive metrics
- Spatial scaling
- Local specificity
- Modifiable by anyone
- Clear user interface

Open and Accessible

- Users
  - Project developers
  - Elected and appointed decision-makers
    - Board of supervisors
    - Council members
    - Planning commissioners
  - Regional agencies
  - Researchers

- Microsoft Excel
  - All formulas can be accessed and changed
  - All data can be modified for local conditions

source: http://digiphile.wordpress.com/

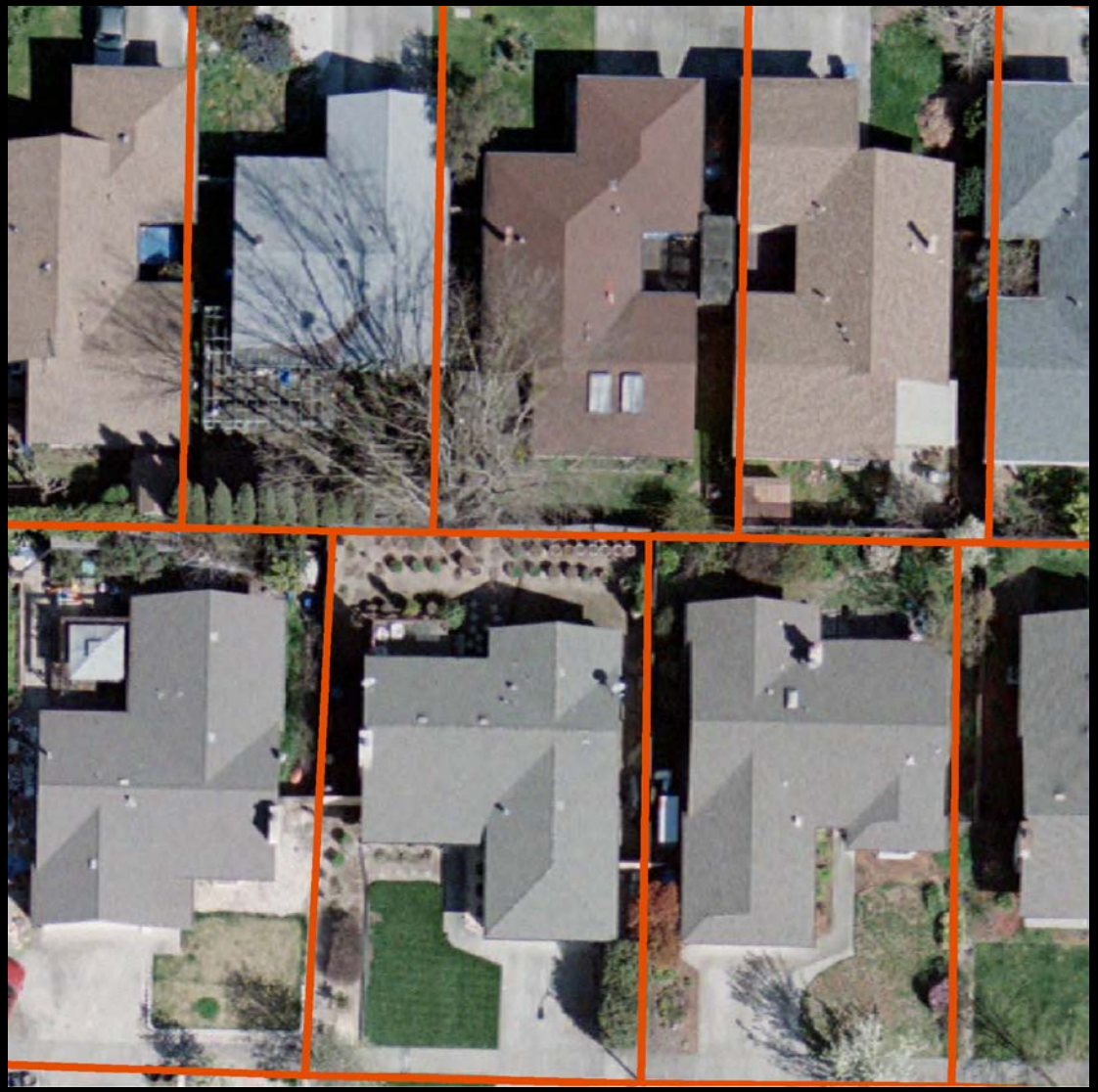
Scaling Up

- How do development choices scale?
  - Lot
  - Neighborhood
  - City
  - County
  - Watershed

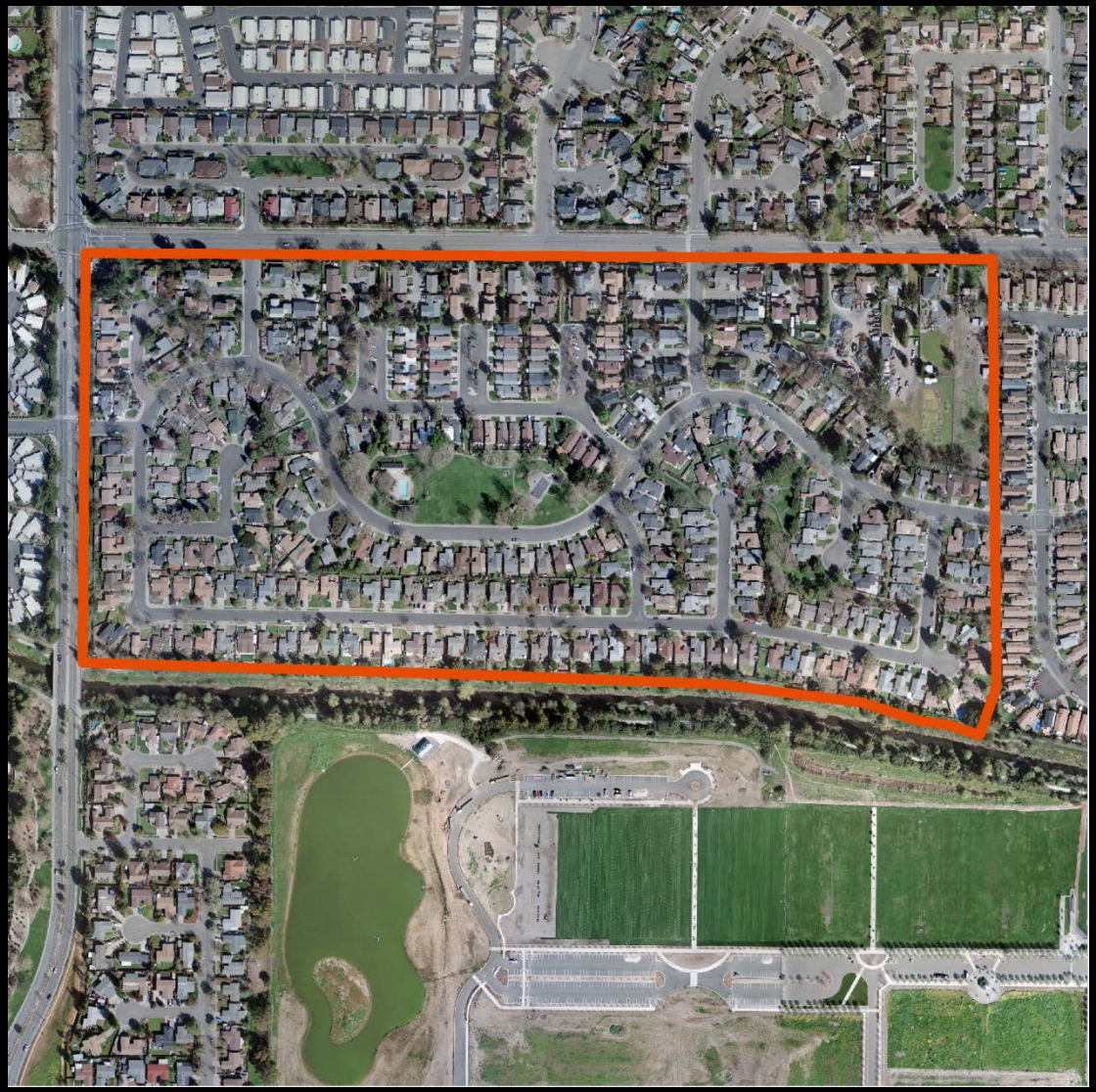
- Focus of this tool: what is the impact of residential?

Study Area: Sonoma County

Lot

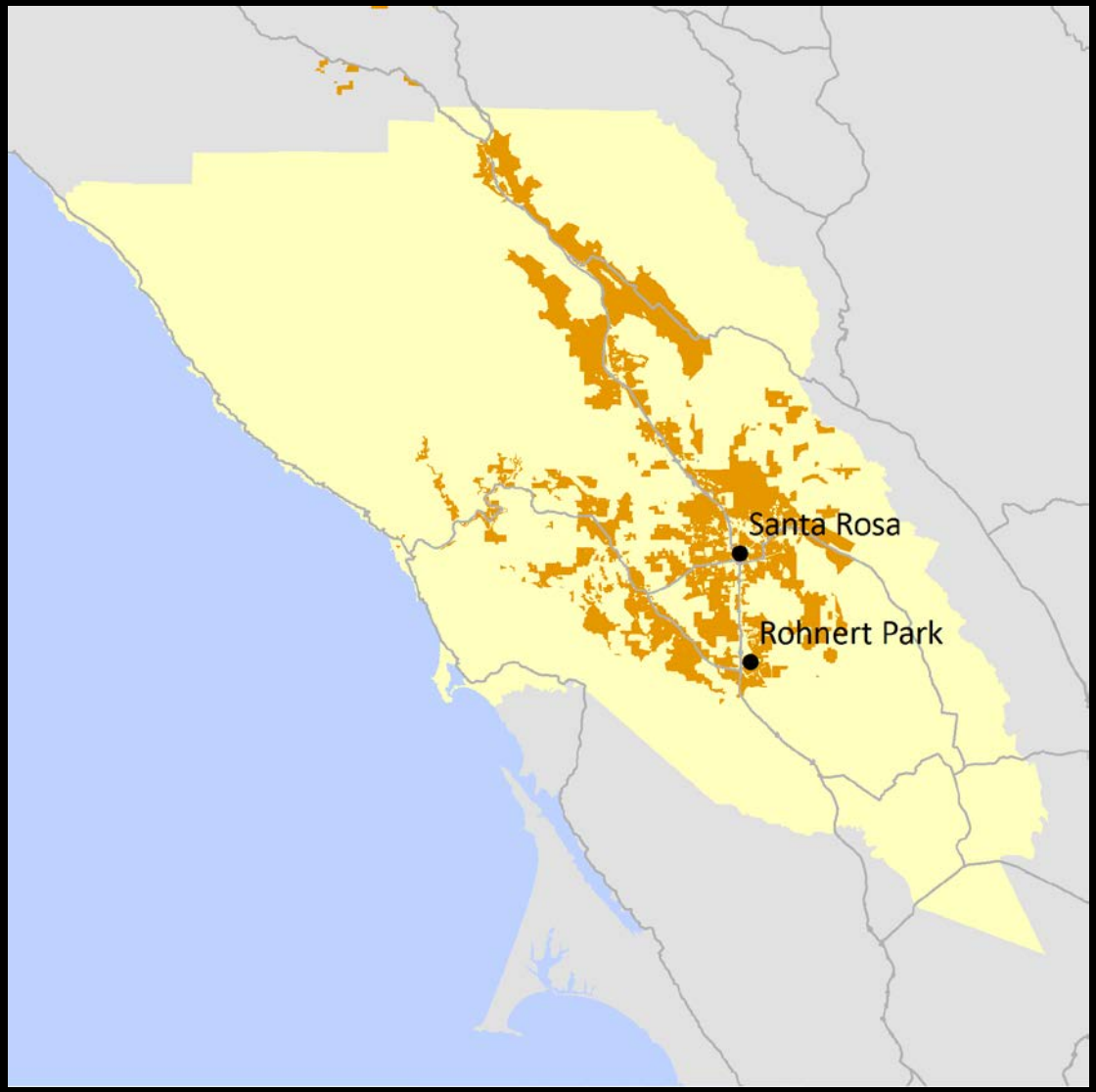


Neighborhood

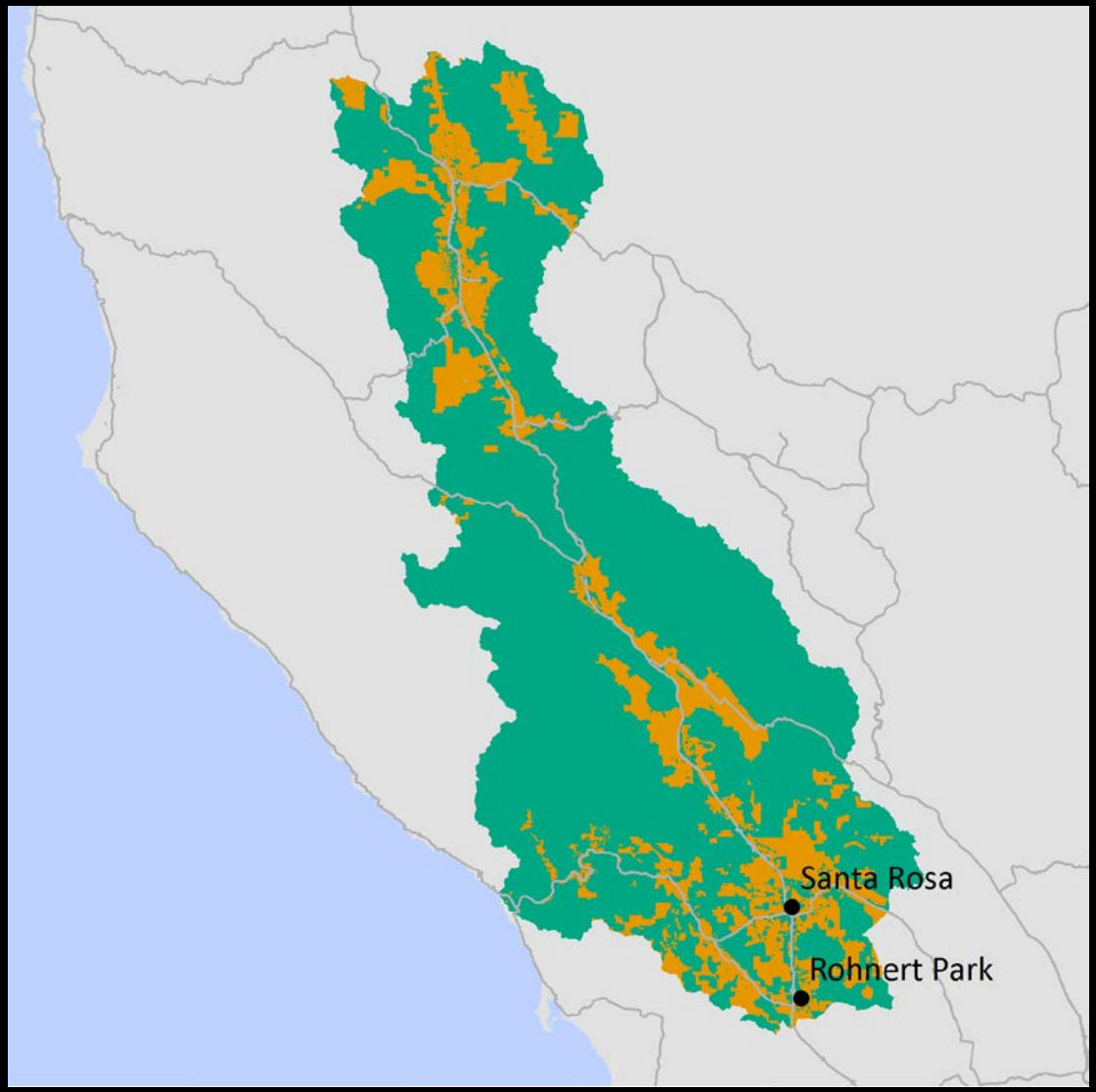


City or Town

County



Watershed



Comprehensive Metrics

1. Percent Impervious Surfaces
2. Stormwater Runoff (from Impervious Surfaces)
3. Outdoor Water Requirements
4. Greenhouse Gas Emissions (from Outdoor Water)

Comprehensive Metrics

5. Cost of Implementation
6. Cost over 50 years
7. Cost over 100 years

Percent Imperviousness

1 2 3 4 5 6 7

Stormwater Runoff

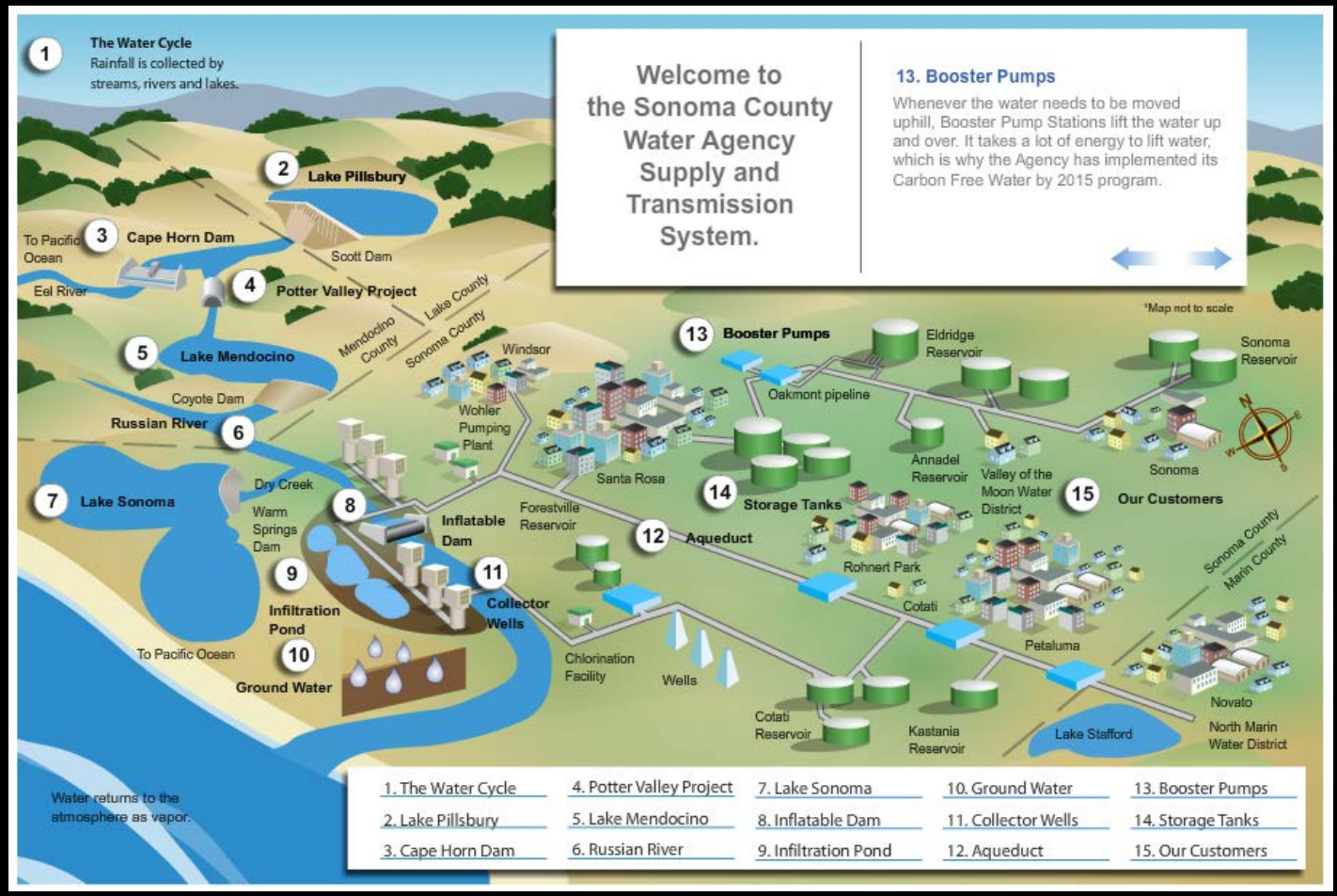
Month	Rain (in)
January	4.05
February	4.78
March	3.83
April	2.18
May	1.62
June	0.43
July	0
August	0
September	0
October	1.79
November	2.19
December	7.47

Outdoor Water Requirement

WUCOLS

- Evapotranspiration zone (ET)
- Species-specific plant water use coefficient
- Planting density
- Environmental exposure
- Irrigation efficiency

Greenhouse Gasses



Cost of Implementation

	Construction Cost ($)			Maintenance Cost			Lifespan (Years)			Source
Green Roof (Sq Ft)	22	28.5	35				20		30	Bertotti
Permeable Pavement - Pavers (Sq Ft)	17	19.5	22				25		50	Bertotti
Permeable Pavement - Porous Asphalt (Sq Ft)	1.98	2.25	2.6							Empire A
Permeable Pavement - Porous Concrete (Sq Ft)	4.5	6	7.5							Empire A
Permeable Pavement - Gravel (Sq Ft)	6	7	8				25	37.5	50	Bertotti
Turf (Artificial) (Sq Ft)	9	10	11				15	20	25	http://w
Turf (Lawn) (Sq Ft)	0.75	1	1.25				10	15	20	Berottti
Native Plants (1 gallon/1 sq.ft.)		8.45								DetailsLa
Rain Garden										
Trees (15 gallon/per tree)	115	132.5	150					15		Ron DeN
Tree Box Filters		7100								DetailsLa
Bioswales (18"x18"/sq.ft.)		37.25								DetailsLa
Downspout Disconnection		225								Letitia Ha
Planter Boxes (avg. size 4 x 8)		354								DetailsLa
Rain Barrels (per 100 gallon reservoir)		580								DetailsLa
Rain Harvesting System - Welded Steel Tank		6900						35		Nicole O
Rain Harvesting System - Poly Tank		3810.4						20		Nicole O
Vegetated Filter Strips										
Amended Soil (Cubic Yard)	35	42.5	50							Bertotti
French Drain (Cubic ft avg)		14								DetailsLa
Greywater system (sq ft)		0.50								http://gr
Irrigation Controller (includes wiring)		394								DetailsLa

Methods Used

- Sources include:
  - private and commercial contractors,
  - landscape developers and architects,
  - plant nurseries, public agencies, and web-based research.
- Methods:
  - Over the phone, email, web-based.

Data Limitations

- Cost data availability varied and is still in progress
- Prices often differed between multiple sources so they were averaged together.

Maintenance and Lifecycles

Predicated on various conditions:

-weather, maintenance, quantity of water expose, quality of component, quality of installation, and intensity of use.

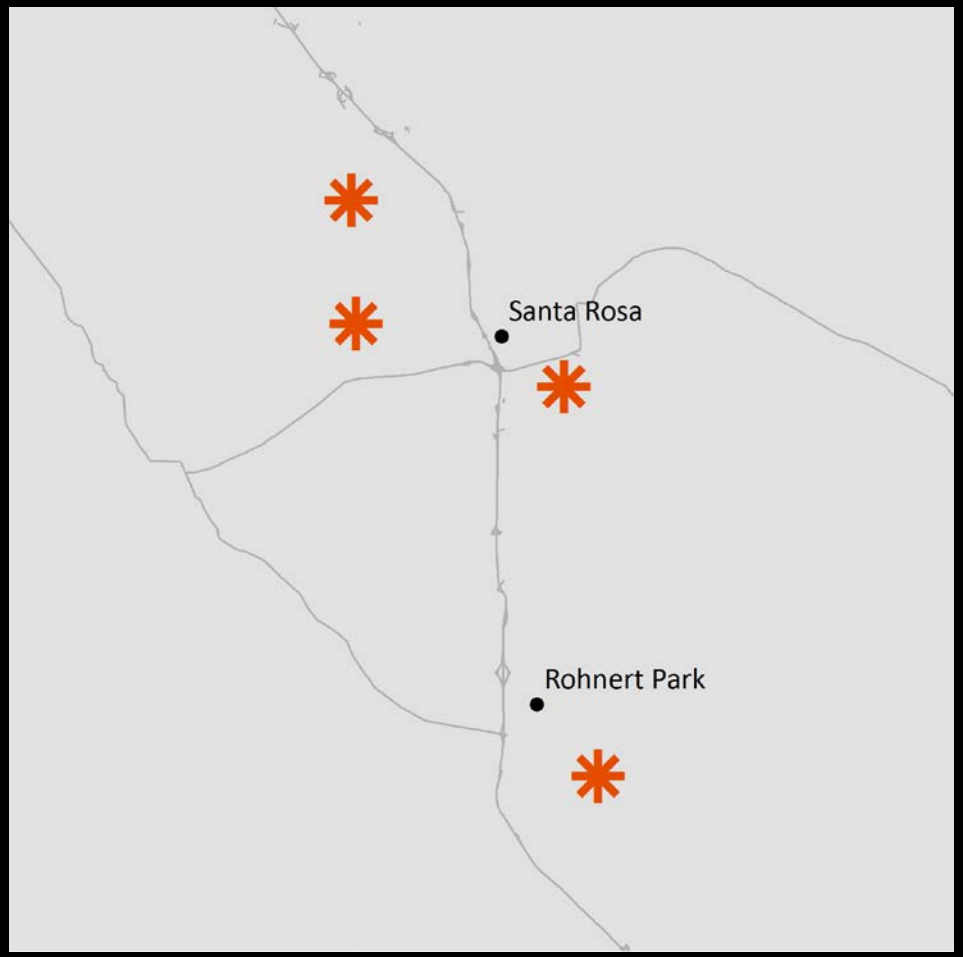
Selecting Case Studies

Single Family Residential:

- Traditional
- SUSMP
- GreenPoint

Mixed Use (including SFR):

- One Planet



Case Study Characteristics

TRADITIONAL (1977):
301 residential units, 6 units/acre

SUSMP (2005):
149 residential units, 9 units/acre

GREENPOINT (2005):
162 residential units, 4.58 units/acre
Not yet completed

ONE PLANET (2010):
1892 residential units, 10.5 units/acre
Not yet completed

Stormwater Regulation Differences

TRADITIONAL:

Pre-stormwater runoff regulations (initiated in 1987)

SUSMP:

Adhered to local regulations

GREENPOINT:

Adhered to local regulations and Cal Green Codes

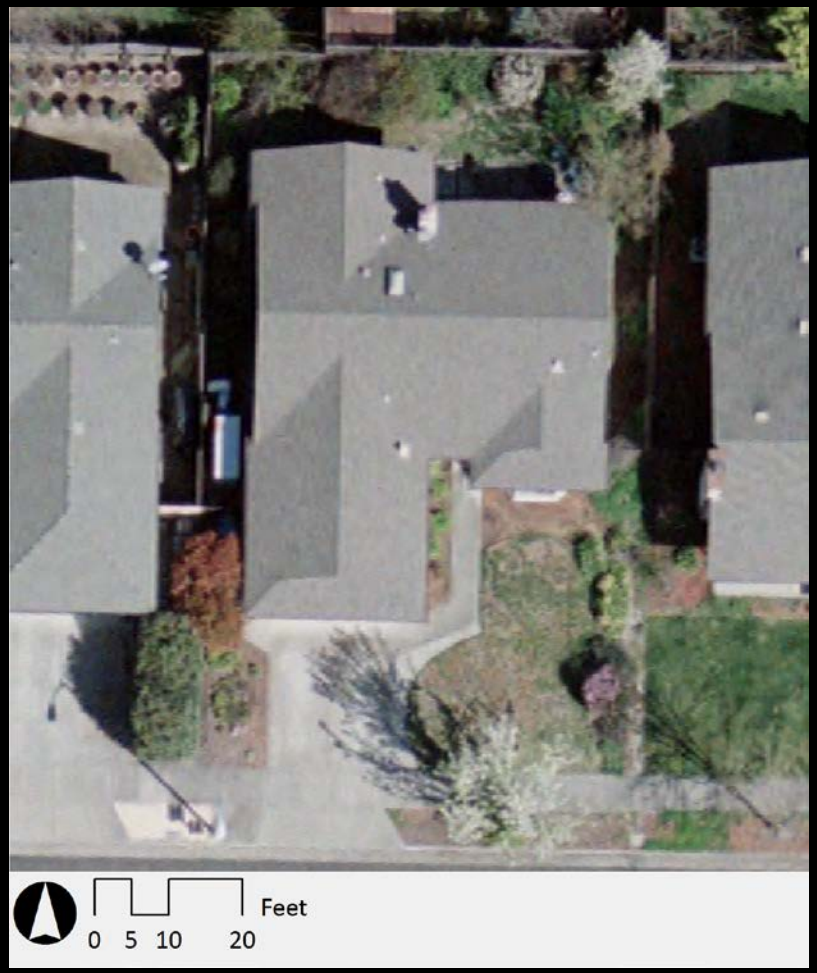
ONE PLANET:

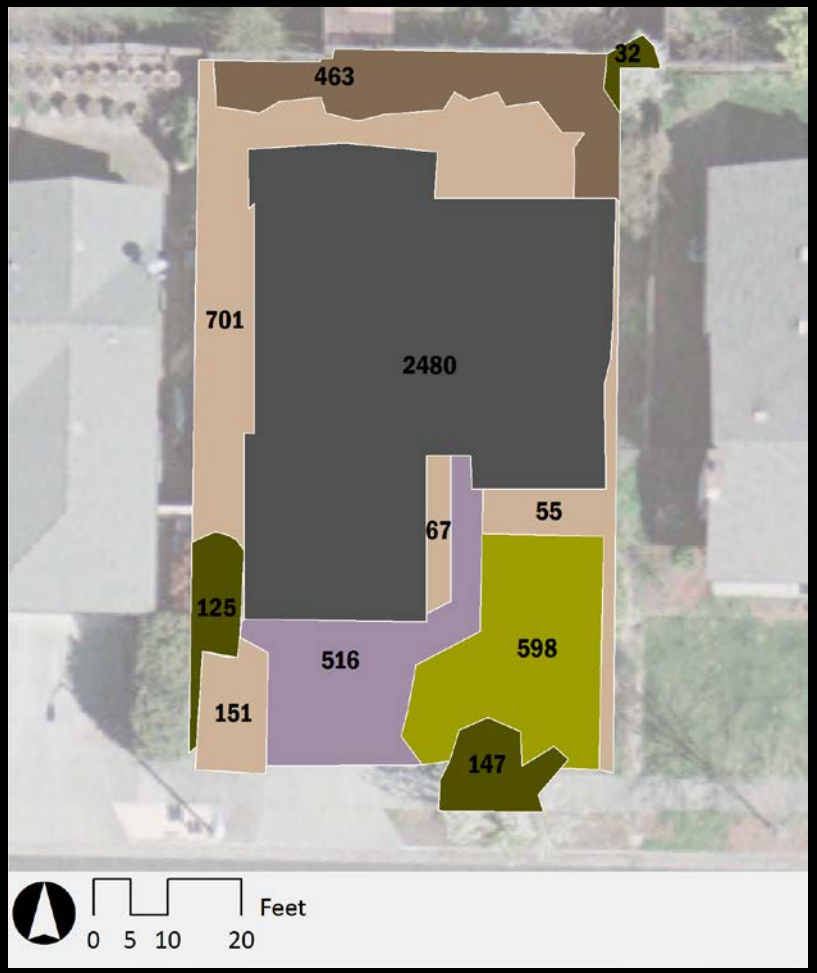
Adhered to local regulations, Cal Green, LEED, One Planet standards

Tool Inputs

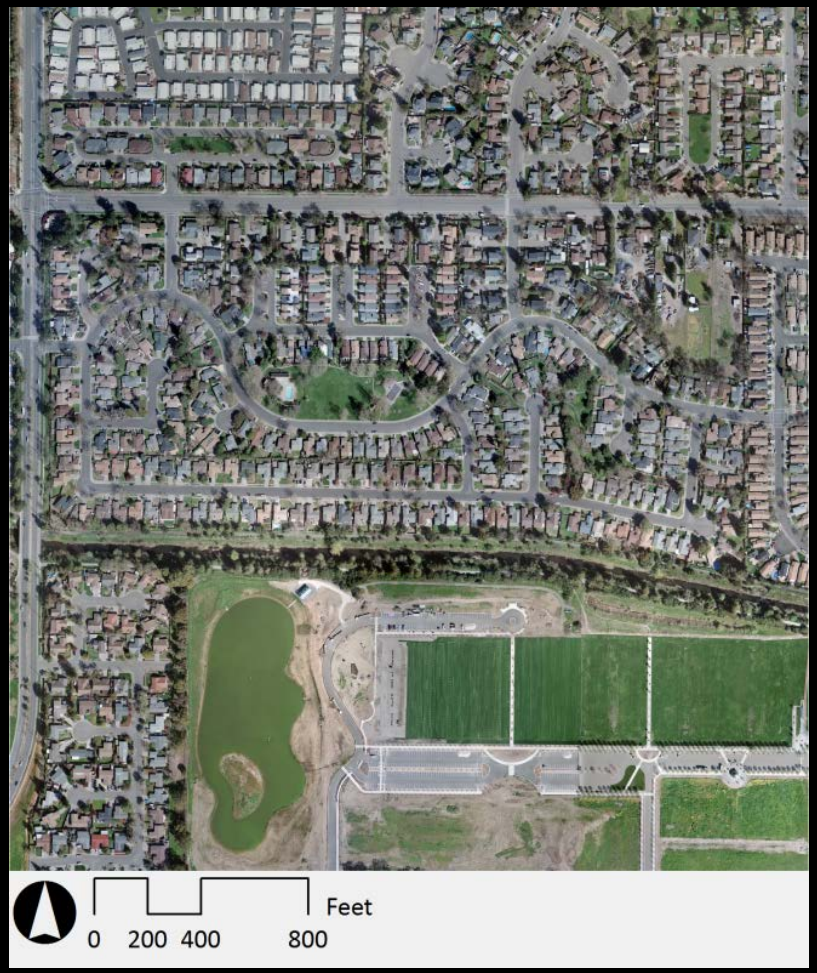
- Land cover
- Water infrastructure

Translating from Site to Tool

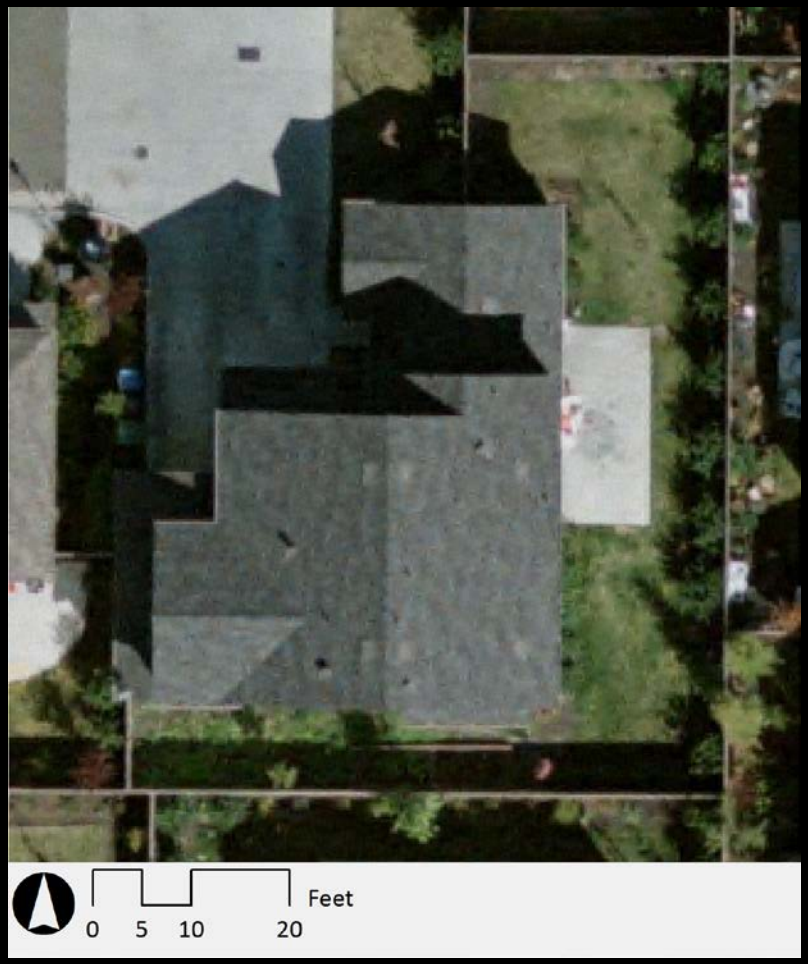


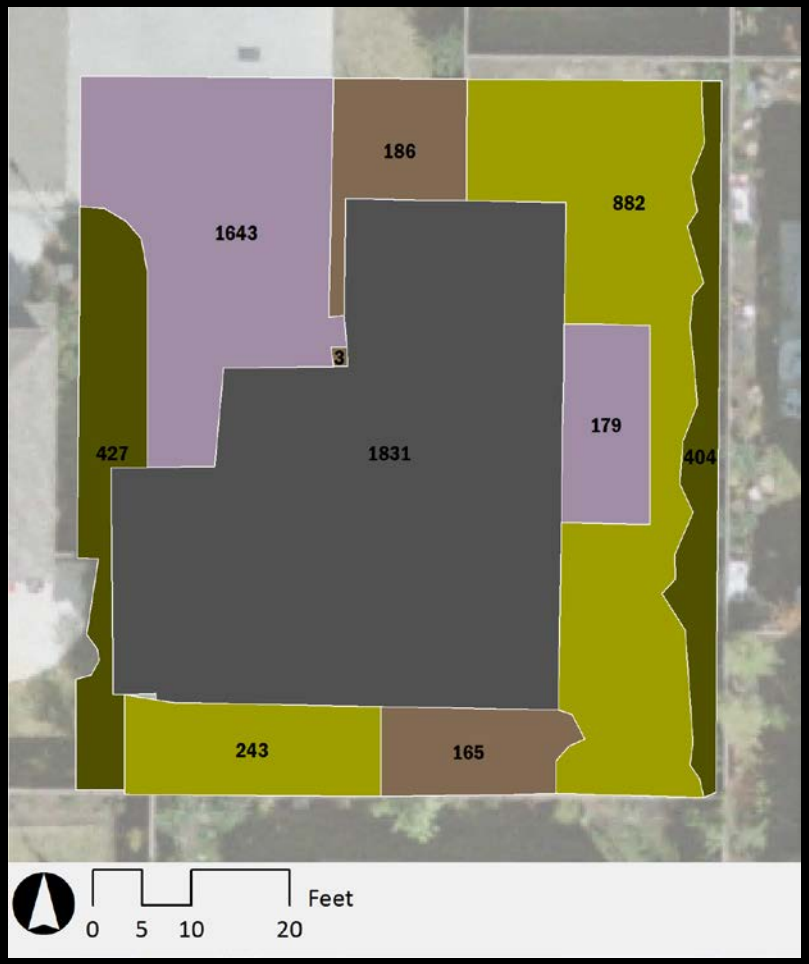


Traditional Neighborhood

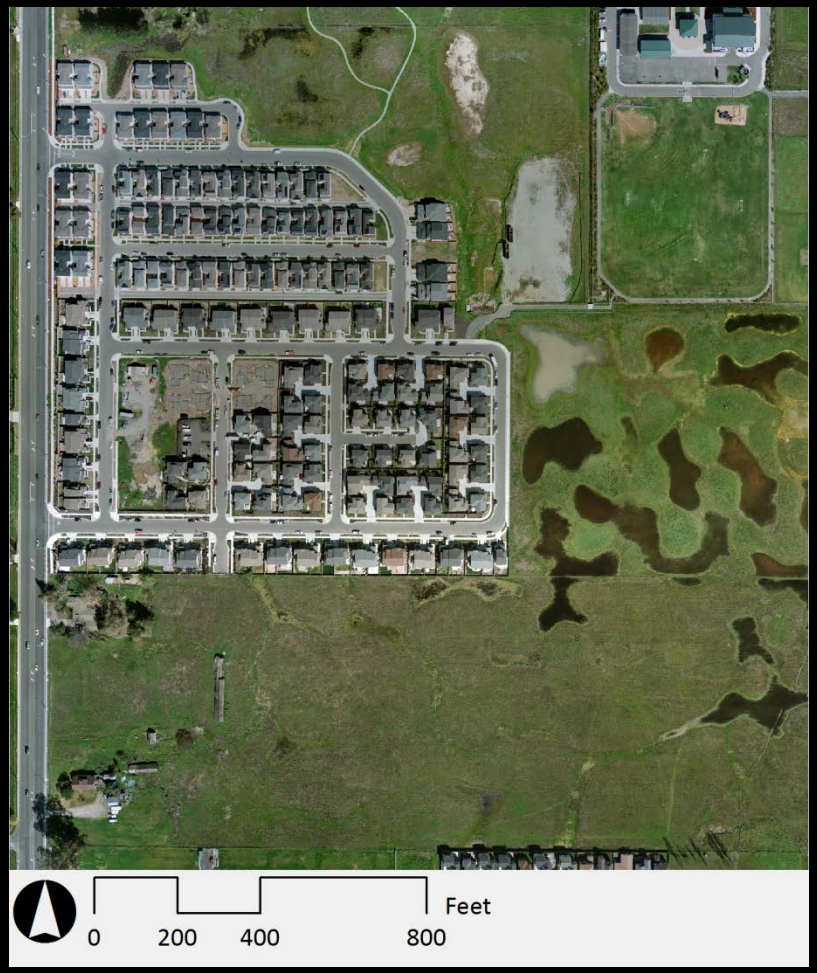


SUSMP

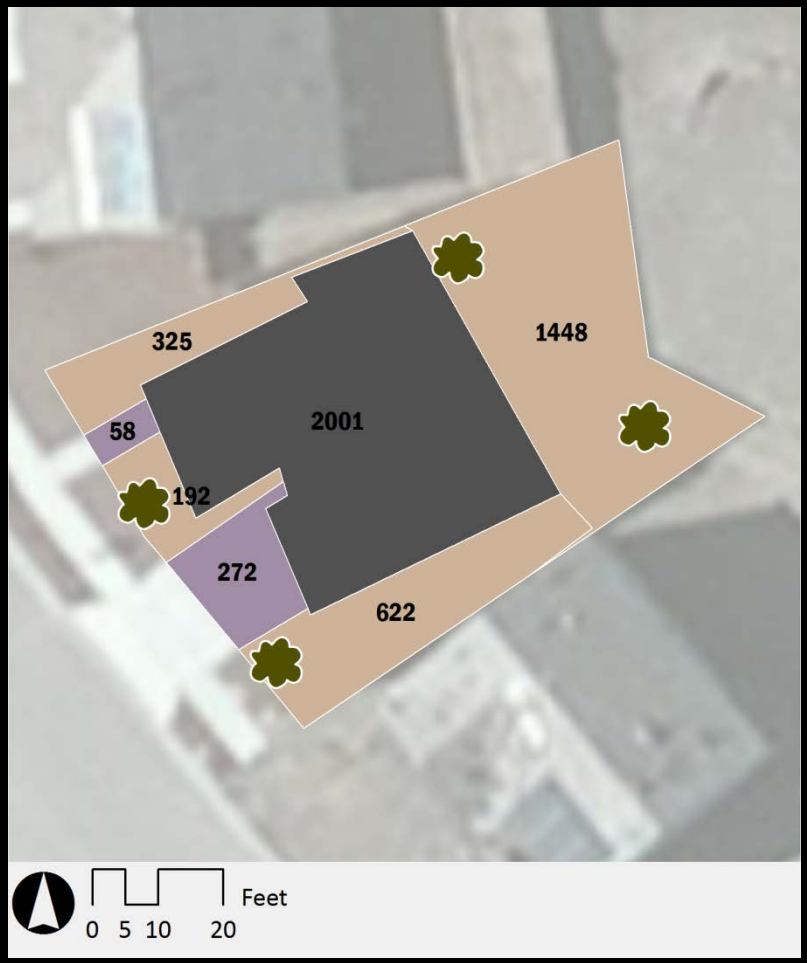

Feet
0 5 10 20


186
882
1643
3
179
427
1831
404
243
165
Feet
0 5 10 20

SUSMP Neighborhood



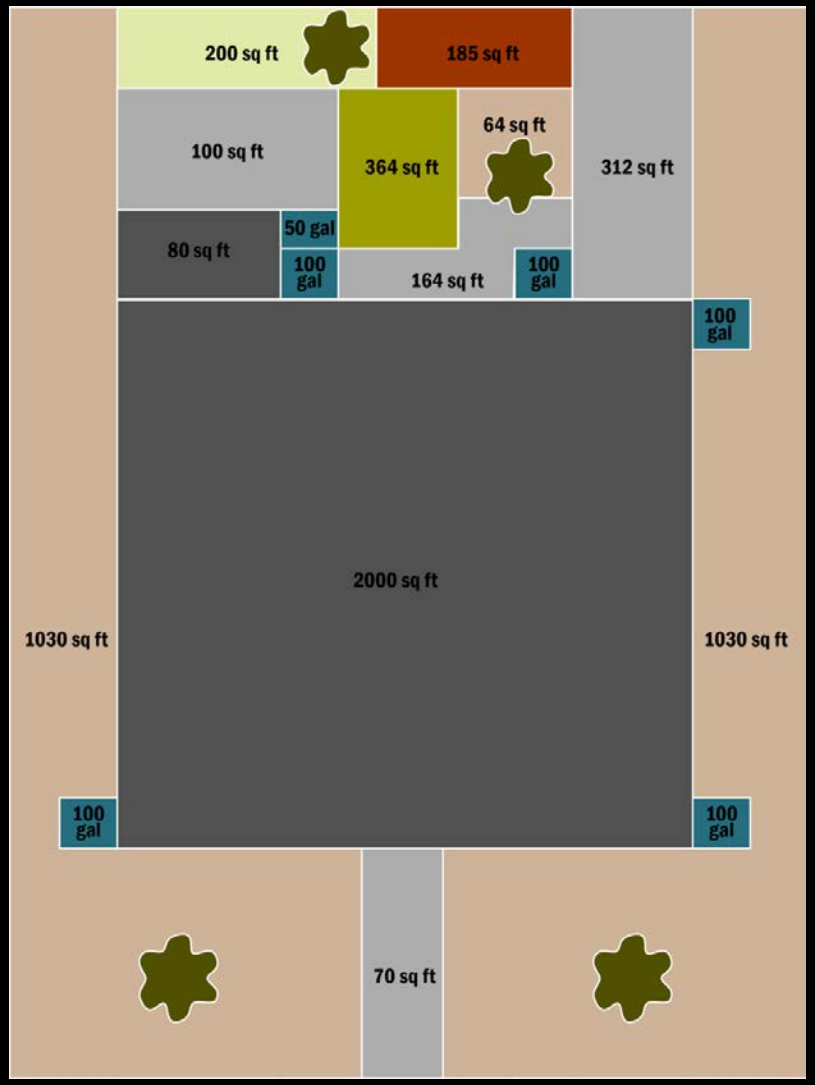
GreenPoint



GreenPoint Neighborhood

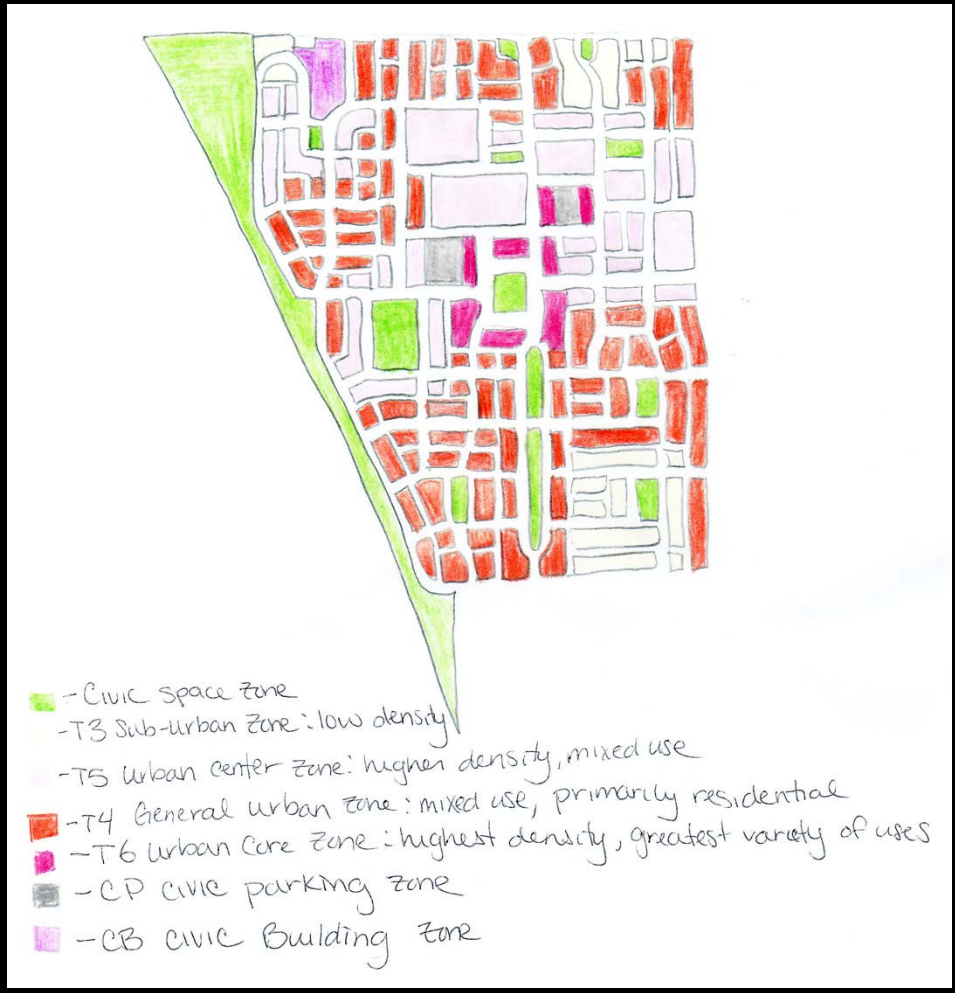
Estimating One Planet Lots

- City's Code of Ordinances
  - Lot Size
  - Space Between Structure and Lot Line
  - Location and Size of Driveway
  - Maximum Percent Turf
- Landscaping
  - Combine Zoning Code With Own Discretion
  - Turf
  - Trees
  - Remaining Landscaping
    - Rain Garden
    - Rain Barrels



One Planet Neighborhood

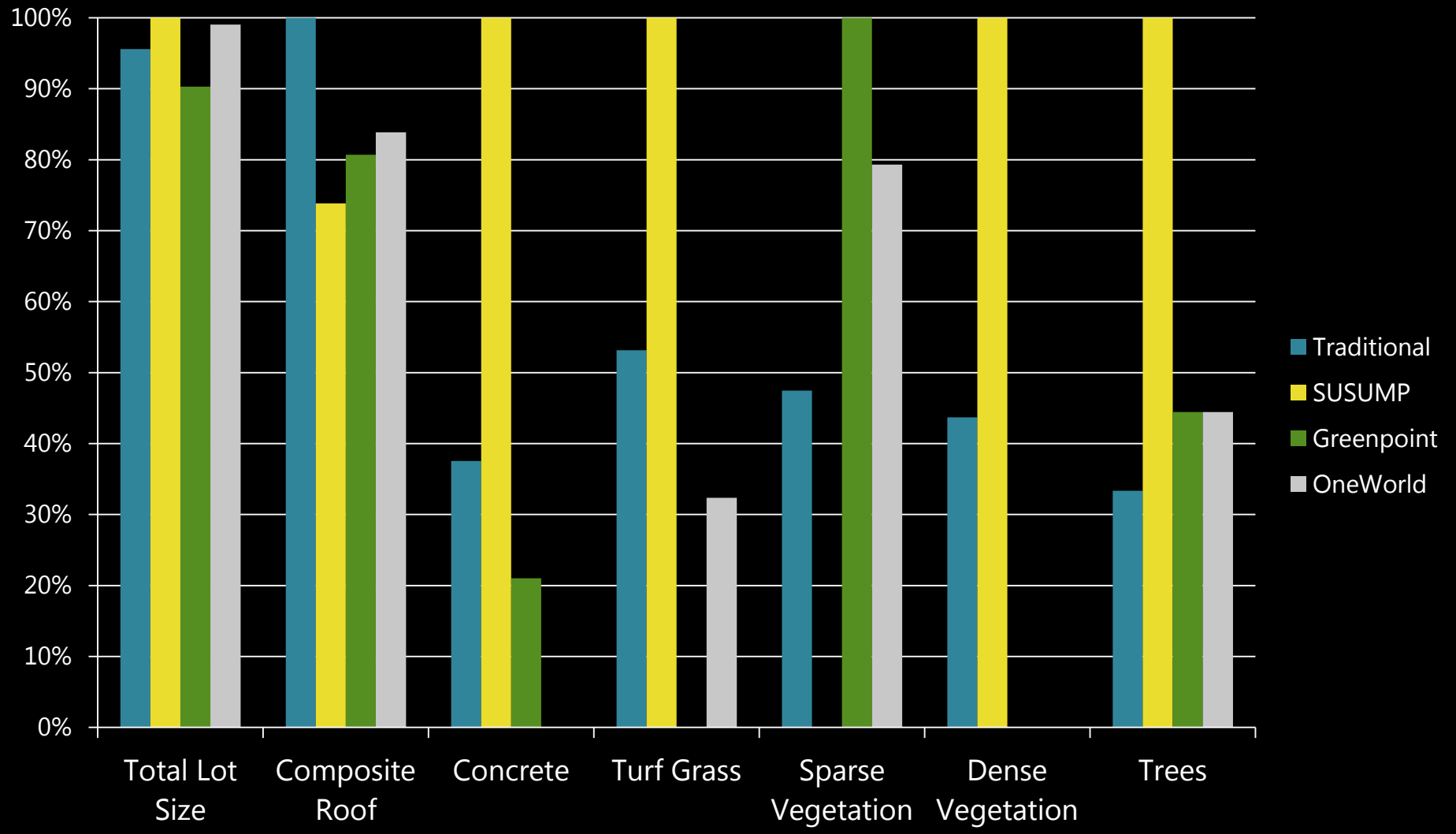
- Streets
  - City's Streets and Roadway Design Standard
- Sidewalks
  - City's Code of Ordinances
- Size, Housing Location, Green Space, Type of Streets, Parking Areas
  - Final Development Plan



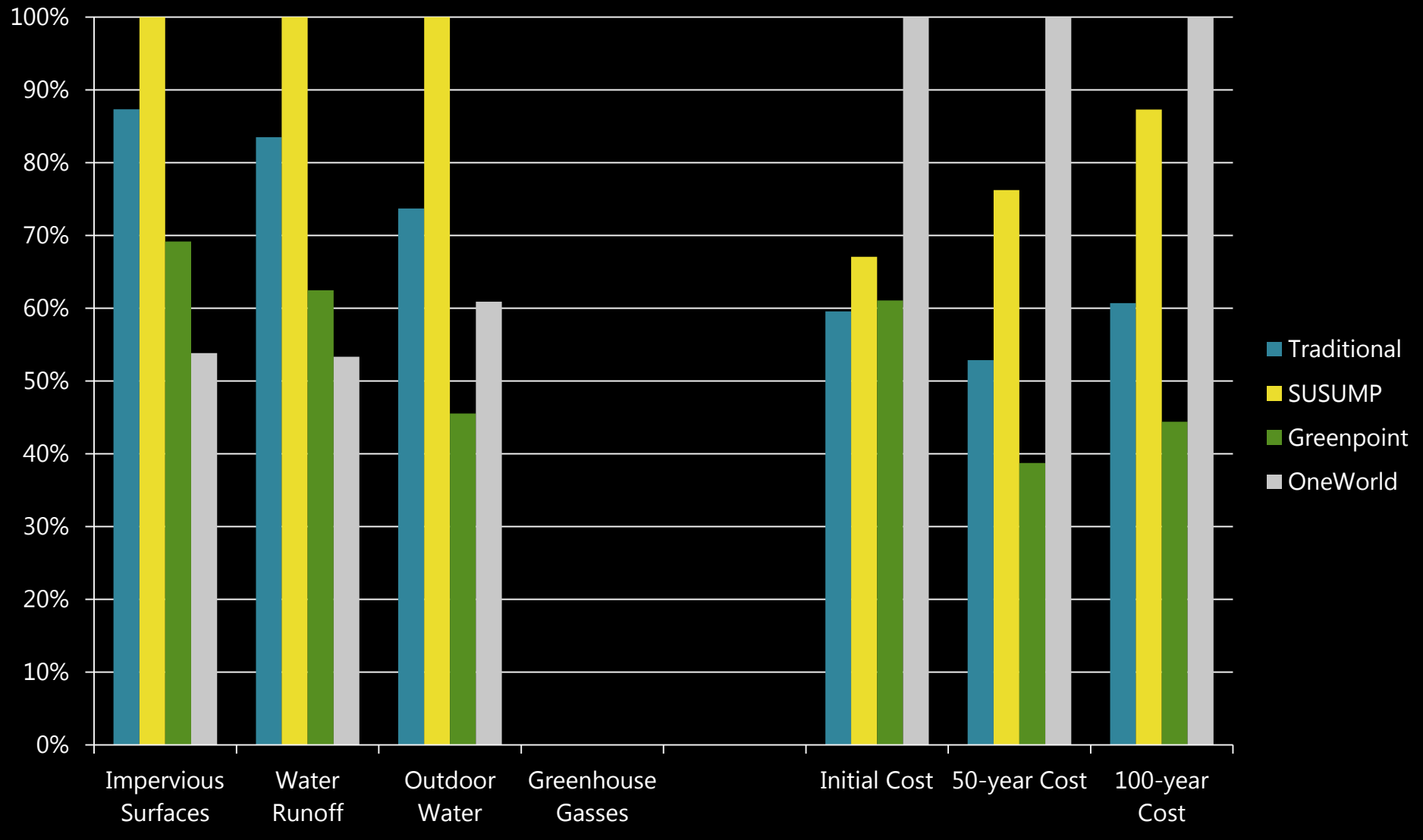
Preliminary Results: Land Cover

	Copperfield	Woodbridge	Meritage	SMV
Total Lot Size	5,318	5,562	5,023	5,509
Composite Roof	2,480	1,831	2,001	2,080
Concrete	777	2,069	435	0
Permeable Pavers	0	0	0	828
Turf Grass	598	1,125	0	364
Cultivated Garden	0	0	0	185
Sparse Vegetation	1,228	0	2,587	2,052
Dense Vegetation	235	537	0	0
Trees (count)	3	9	4	4

Preliminary Results: Land Cover



Preliminary Results: Tool Metrics



Preliminary Results: Land Cover

	Copperfield	Woodbridge	Meritage	SMV
Percent Impervious	61%	70%	48%	38%
Peak Monthly Runoff	15,157	18,150	11,337	9,680
Peak Monthly Outdoor Water	4,492	6,094	2,775	3,711
Peak Monthly GHG	0	0	0	0
Cost, Implementation	$23,828	$26,835	$24,431	$40,013
Cost, 50 years	$32,816	$47,328	$24,053	$62,078
Cost, 100 years	$65,034	$93,531	$47,575	$107,116

Preliminary Findings

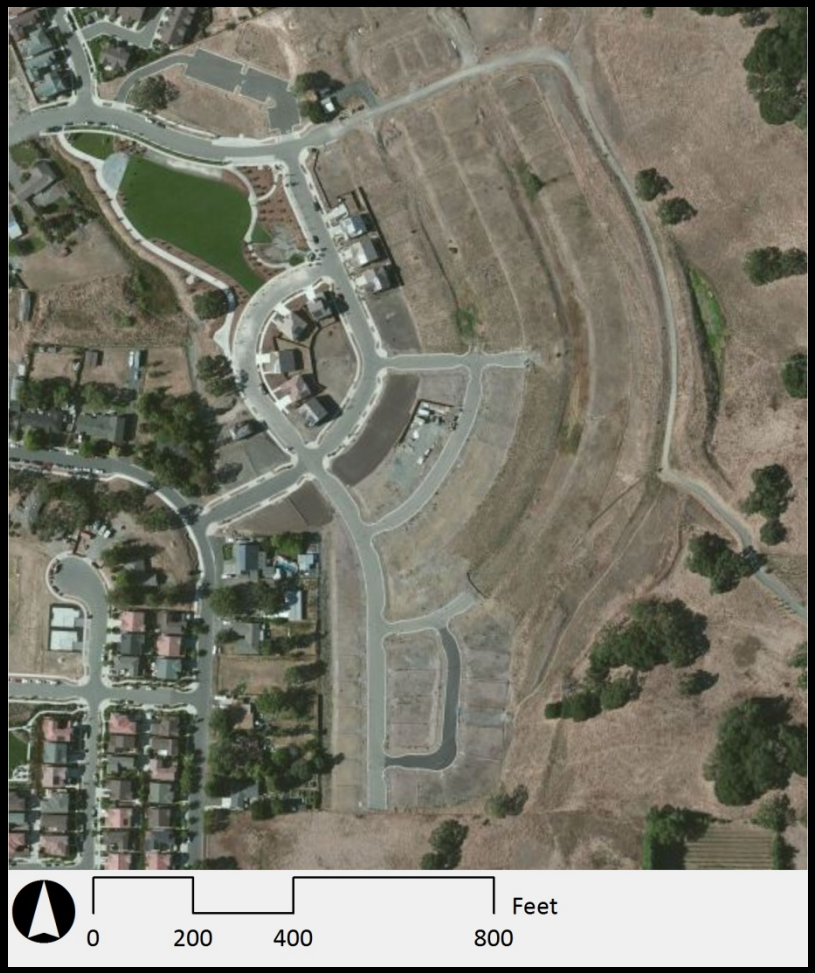
- There are few user-friendly tools which test and compare Low Impact Development scenarios
- Data is inconsistently available
  - Maintenance
  - Green infrastructure
- Less infrastructure is cheaper
  - Most cost effective residential development has least impervious surfaces

Less Infrastructure is Less Expensive

- Impervious surfaces are costly
  - Replacement of surfaces over time
  - Storm water runoff requires even more infrastructure
- Better to adapt than mitigate
  - Less additional infrastructure is best

Not all Infrastructure is Equal

- Upfront costs
- Lifecycle costs
  - Maintenance
  - Replacement
- Spillovers
  - Green infrastructure as public amenities



Simple is Good

Opportunities/Challenges

- Align cost incentives
  - Who builds?
  - Who maintains?
  - Who benefits?
- Link upstream LID and downstream grey infrastructure
  - Watershed planning
  - Cumulative impacts
- Importance of spatial scales

Actions

- Reduce hardscape
- Limit building footprints
- Plan for water-smart landscapes and developments

Questions? Comments?